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ABSTRACT

This study involved a longitudinal examination of a program designed for paraeducators enrolled in an Urban Preservice Degree Articulation in Teacher Education (UPDATE) program. During the first year, 16 paraeducators successfully completed a series of mathematics courses taught using constructivist instructional methods. These user-friendly mathematics courses offered at a community college through the UPDATE program in 1998 had a positive impact on paraeducators' attitudes toward mathematics. In 1999, during the second year of the program, 14 of the same paraeducators enrolled in an introductory biology course taught using traditional methods (lectures and notetaking). Researchers administered two quantitative surveys, an attitudinal survey, and an instructional strategy survey, and conducted a focus group. Pre- and post-intervention scores on the attitudinal survey were analyzed for any significant change in paraeducators' attitudes toward science. The instructional survey was also administered at the end of the course to collect information about teaching methods used and to learn how these methods impacted learning. Data from the surveys and focus group suggested that use of traditional instructional methods had a negative impact on paraeducators' attitudes toward teaching and learning science. (Contains 33 bibliographic references.) (SM)

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The Impact of Instructional Methods on Preservice Teachers' Attitudes Toward Teaching and Learning

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Abstract

The purpose of this study was to conduct a longitudinal examination of a program designed for paraeducators enrolled in an Urban Preservice Degree Articulation in Teacher Education (UPDATE) Program. During the first year of the program sixteen paraeducators successfully completed a series of mathematics courses taught using constructivist instructional methods. These user-friendly mathematics courses offered at Springfield Technical Community College through the UPDATE Program, during Summer and Fall 1998, had a positive impact on paraeducators' attitudes toward mathematics (Gibson, Brewer, Magnier, McDonald & Van Strat, 1999). During the second year of the program, Summer 1999, fourteen of the same paraeducators enrolled in an introductory Biology course that was taught using traditional methods (i.e., lectures and note taking). Two quantitative surveys, an Attitudinal Survey and an Instructional Strategy Survey, were administered; a focus group was also conducted. Pre and post scores on the Attitudinal Survey were analyzed for any significant change in paraeducators' attitudes toward science. The Instructional Survey was administered at the end of the course to collect information about the teaching methods used and to learn how these methods impacted learning. Data from the surveys and a focus group suggested that the use of traditional instructional methods had a negative impact on paraeducators' attitudes towards teaching and learning science. These findings provide evidence that a college level introductory Biology course taught using lectures and note taking had a negative impact on UPDATE Scholars' attitudes towards science.

The Impact of Instructional Methods on Preservice Teachers' Attitudes Toward Teaching and Learning

The purpose of this study was to conduct a longitudinal study of a program designed for paraeducators enrolled in an Urban Preservice Degree Articulation in Teacher Education (UPDATE) Program. During the first year of the program paraeducators were exposed to mathematics content using constructivist instructional approaches: collaborative group work, problem solving, the use of manipulatives, and calculators. These user-friendly mathematics courses (reformed courses) offered at Springfield Technical Community College through the UPDATE Program, during Summer and Fall 1998, had a positive impact on paraeducators' attitudes toward mathematics (Gibson, Brewer, Magnier, McDonald & Van Strat, 1999). Because of the limited availability of reform minded science instructors, during the second year of the program paraeducators were enrolled in a traditionally taught science course (a non-reformed course): lectures and note taking.

Inquiry-based instruction continues to receive considerable attention from both science and mathematics education reform movements. The National Council of Teachers of Mathematics (NCTM, 1989; 1991; 1995), the Mathematical Association of America [MAA] (Tucker & Leitzel; 1995), the National Research Council (NRC, 1996), and the American Association for the Advancement of Science (AAAS, 1993) advocate using a constructivist method of teaching, in which learners construct knowledge. Reformed teaching at the college level is particularly important for future K-12 teachers, because literature on teacher education posits that teachers tend to teach the way they were taught when they were students (Brown & Borko, 1992; Kennedy, 1991). Future

teachers spend thousands of hours in classrooms watching what heir instructors do and develop beliefs about teaching based on their experiences. This is why it is so important that college level mathematics and science courses should model the type of teaching that is consistent with the educational reform movement. College faculty should model "good teaching" that uses constructivist instructional strategies for pre-service teachers. Yet, many college math and science professors still continue to emphasize covering content using a traditional lecture and note taking approach.

Studies have been conducted that compare the difference between traditional and constructivist teaching methods using two different groups of secondary school students. In most of these studies, one group of students is exposed to traditional methods of science instruction while a different group of students is exposed to constructivist methods of science instruction (Chang, Chun-Yen & Mao, Song-Ling, 1998; Ertepinar & Geban, 1996; Geban, Askar & Ozkan, 1992; Gibson, 1998; Jaus, 1977; Mattheis & Nakayama, 1988; Padilla, Okey & Garrand, 1984; Purser & Renner, 1983; Saunders & Shepardson, 1987; Scheider & Renner, 1980; Selim & Shrigley, 1983; Shrigley, 1990; Wollman & Lawson, 1978). Overall, these studies conclude that inquiry-based science activities have positive effects on students' science achievement, attitudes toward science and school, cognitive development, laboratory skills, science process skills and understanding of science knowledge as a whole when compared to students taught using a traditional approach.

Much research has focused on comparing the two methods of instruction. However, in all of these studies two different groups of students were exposed to the two different instructional methods. Research that looks at the impact of the two different

types of instruction on the same group of students has rarely, if ever, been conducted. In this study we had an opportunity to document the experiences of preservice teachers who were exposed to both types of instructional methods (constructivist and traditional approaches; reformed and non-reformed courses) and try to understand how instructional methods impacted preservice teachers' attitudes toward teaching and learning mathematics and science.

Background

Project UPDATE a collaboration between Springfield Technical Community College (STCC), the University of Massachusetts-Amherst School of Education, the University of Massachusetts (UMass)/University Without Walls and the Springfield Public Schools was designed to address several key issues: the need for a higher proportional representation of teachers of color in an urban school, the need to develop teachers who are multiculturally sensitive, technologically competent and able to help children in urban schools to cope with the complex social issues facing them. Preliminary research revealed that many paraeducators in the Springfield Public Schools were people of color who were interested in becoming teachers.

The UPDATE program is supported through a three-year grant from the Fund to Improve Post-secondary Education (FIPSE). The grant supports the development and piloting of an Associate of Arts to Bachelor of Arts teacher education curriculum that is designed to meet the educational challenges of urban schools. A major goal of the program was to pilot improved methodologies for delivery of multiculturally rich, technologically relevant courses to adult learners (paraeducators in Springfield City

Schools) who were already immersed in urban public educational issues and who desired to become certified to teach. UPDATE recognizes urban school systems as major employers struggling to hire a "new breed" of teachers prepared to meet the social and technological challenges inherent in urban classrooms of the future. It provides access, support, a new preservice curriculum, and an alternative model.

UPDATE Scholars continue to work full time as paraeducators while attending college part time. Individuals with little or no college experience begin at STCC and work towards an Associate of Arts degree. Upon completion of their Associate of Arts degree, UPDATE Scholars continue to work toward their Bachelor of Arts degree from the University of Massachusetts-Amherst through the UMass University Without Walls (UWW) program. Paraeducators who already have a significant amount of college experience go directly into the UWW program. Through UWW, students may acquire credit for experiential learning. UPDATE Scholars also acquire a Teaching Certificate (Early Childhood or Elementary) through the University of Massachusetts School of Education. Most courses are offered in Springfield at STCC. UPDATE Scholars are eligible for both federal and state financial aid.

STCC successfully leveraged additional funds to support the UPDATE program. Resources from the Eisenhower Professional Development program were secured: 1) to help support pre-enrollment coordination; 2) to revise existing courses to include integrated academics, the Commonwealth of Massachusetts Department of Education Curriculum Frameworks, and applied learning theory; 3) to support students' hands-on exposure to technology as an integral part of the liberal arts and sciences design; 4) to increase UPDATE Scholar's English language proficiency through ESL and pre-college

literacy programs; and 5) to enhance learning in mathematics, science, and technology through readiness activities.

Eisenhower initiatives have included the redesign of STCC's Education Transfer Option courses. Redesign initiatives included:

- A curriculum enhanced with technology.
- Course content, which emphasizes the rich cultural and racial diversity, reflected in today's society.
- General Education courses delivered in a constructivist mode. Learning that is student-active oriented, inquiry-based, and collaborative (the use of multiple strategies to engage students with different learning styles and honor a range of abilities).
- Infusion of the Massachusetts Curriculum Frameworks, as appropriate, into liberal arts and science courses.
- Development and designation of learner outcomes and competencies.

Mathematics and Science Courses

Three mathematics courses were offered at STCC during Summer and Fall 1998 (Elementary Algebra I, Elementary Algebra II (both pre-college level mathematics courses), and Math for Early Childhood/Elementary Teachers, a college level mathematics course). All three mathematics courses were taught using a wide range of instructional strategies (e.g., collaborative group work, problem solving, the use of manipulatives, and calculators). This series of constructivist mathematics courses had a

positive impact on paraeducators' attitudes towards mathematics (Gibson, Brewer, Magnier, McDonald & Van Strat, 1999).

UPDATE paraeducators enrolled in a basic introductory college level Biology course during Summer 1999. This course was taught using a traditional lecture and note-taking approach (a non-reformed science course). The course is normally taught to over 300 community college students during each Fall semester. Typically five to six faculty members teach different sections of the Biology course. The faculty members work together to make sure that they are all covering the same factual information. They want all sections of the course to be consistent. The overall goal of the course is to establish some fundamental knowledge of cell biology: how cells are put together, how they operate, and what are the constraints on their operation. The focus of the course is to help student learn basic biological facts and concepts.

Participants

Sixteen UPDATE Scholars completed the three mathematics courses (Elementary Algebra I, Elementary Algebra II (both pre-college level mathematics courses), and Math for Early Childhood/Elementary Teachers, a college level mathematics course) during Summer and Fall 1998. They passed all three math courses with a grade of C or better. Fourteen of these UPDATE Scholars enrolled in Principles of Biology 102 during Summer 1999. Only twelve of the UPDATE Scholars passed with a grade of C or better. At the time, one of these paraeducators had already begun working on her Bachelor of

Arts degree in the UWW program at UMass. The other thirteen UPDATE Scholars were still working on their Associate of Arts degree at STCC.

All fourteen UPDATE students, who took the Principles of Biology course, were women. Two were African-American, five were Hispanic and seven were Caucasian. Eight were married, one was single, and four were divorced. Nine of these women had dependent children living at home. Thirteen of the UPDATE scholars started the UPDATE program in Spring 1988; one woman started the program during Fall 1999 (she had a number of transfer credits). For these thirteen women the Principles of Biology course was their 4th semester in the UPDATE Program and was their first science course.

UPDATE Scholars took courses during late afternoon and/or early evening while working during the day. This was in addition to keeping up with family responsibilities, which for some were very demanding. Usually UPDATE scholars take 3 to 6 credits per semester. The majority of these women are interested in teaching at the elementary school level, only one expressed interest in teaching at the middle/secondary school level.

Methodology

UPDATE Scholars enrolled in Principles of Biology 102 completed two questionnaires: an *Attitudinal Survey* and an *Instructional Strategies Survey*. The *Attitudinal Survey* (Appendix A) contains 51 statements to which students responded on a Likert scale. That is, each item had five possible responses, ranging from "1-Strongly agree" to "5-Strongly disagree". Student responses to these 51 items were used to look for any changes in students' attitudes over time.

The *Instructional Strategies Survey* (Gibson, Brewer, Magnier, McDonald & Van Strat, 1999) contains 15 instructional strategies to which students responded with one of the following five responses: "Didn't happen", "Happened and not helpful", Happened and somewhat helpful", Happened and very helpful", and "Happened and extremely helpful". Paraeducators' responses to this survey were used to determine what instructional strategies were used and whether the instructional strategies used were helpful to their learning of scientific concepts. In addition, this survey has several questions designed to gather information about how specific instructional strategies helped paraeducators learn and to determine if the learning in the Biology course related to their work as paraeducators.

Data Collection

The two survey instruments as well as focus groups and interviews were used to provide varied perspectives of the program. The *Attitudinal Survey* was administered twice: once during the beginning of the course, and once near the end of the course. *The Instructional Strategies Survey* was administered once near the end of the course. Both surveys were administered in class to all students present on that particular date.

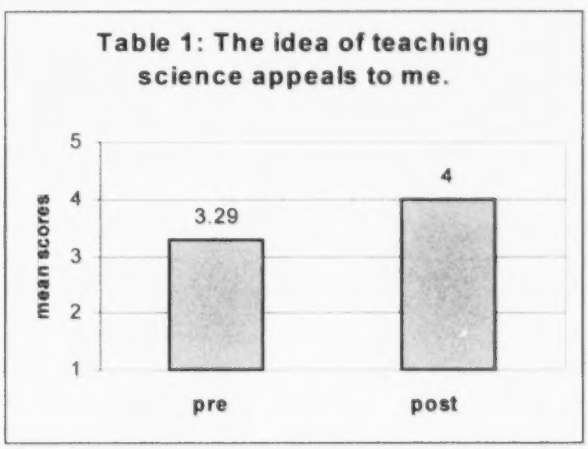
In addition, a focus group with paraeducators enrolled in Principles of Biology 102 was conducted. The purpose of the focus group was to gather information from paraeducators about the overall UPDATE Program and specifically about the Biology course. Participation in the focus group was voluntary and no members of the STCC staff were present. The focus group was audiotaped for transcription purposes only. The

session lasted about 90 minutes. In addition, an informal interview was conducted with the professor who taught the Biology course.

Results

To find out if there were any differences in UPDATE Scholars' attitudes toward science over time, a paired t-test was used to look at the items on the *Attitudinal Survey*. (Any p values less than .05 were considered statistically significant.)

A paired t-test showed that there was a statistically significant difference ($p = .045$) in UPDATE Scholars' attitudes toward teaching science between the beginning and the end of Principles of Biology 102 (Table 1). UPDATE scholars over all attitude pre mean score was 3.29 and their post-mean score was 4.00. Paraeducators' attitudes toward teaching science became more negative after taking Biology.



Responses on the Instructional Strategies Survey and comments made by the paraeducators during the focus group revealed some possible explanations for this

negative impact. Here are some examples of what UPDATE Scholars had to say about the Principles of Biology course:

- *This course was very demanding and challenging.*
- *This course was very stressful.*
- *The workload was overwhelming.*
- *The stress of constant test taking made many paraeducators not want to take any more science courses.*
- *Too much material was covered in this course, too fast.*
- *The professor, on numerous occasions, would try to explain science concepts to them using complex language that they could not understand.*

The way the course was taught may have caused a negative impact on UPDATE Scholars' attitudes toward teaching science. Paraeducators enrolled in this introductory Biology course were expected to memorize the basic facts about biochemistry and cellular biology. They were required to take many tests to demonstrate that they had indeed memorized this factual information.

The UPDATE Scholars said that this course showed them how frustrating it can be for learners to be judged by constant test taking. The focus group with UPDATE Scholars revealed that many did not look forward to taking any more science courses because of their negative experience in this introductory Biology course. The UPDATE Scholars said that they were not interested in memorizing a lot of scientific facts and information to pass a test to meet their College's science requirements. They said they

really wanted to learn science and understand concepts, instead of just regurgitating facts and information.

The professor who taught the Biology course said that this course was designed to present straightforward factual information that people needed to master before they could have discussions or do anything else with the information. He/she felt that the best way to get this information across to students was by lecturing, as lecturing is an efficient way to transmit knowledge from the instructor to the student. The professor said that he/she realized that teaching in this manner was less interesting to students, but this course was designed for students to learn specific facts, such as, what cells are made up of and how they work. He/she admitted that this introductory Biology course was not designed to really convey the nature of scientific inquiry.

Conclusion

The three mathematics courses UPDATE students took during Summer and Fall 1998 were taught using a constructivist approach. This method of teaching had a positive impact on paraeducators' attitude towards mathematics (Gibson, Brewer, Magnier, McDonald & Van Strat, 1999). In addition, the data indicated that these instructional methods also helped paraeducators learn mathematics. Constructivist teaching methods improved UPDATE students' attitudes toward mathematics and it also helped them learn mathematics. This user-friendly method of instruction was important to pre-service teachers developing good attitudes toward mathematics.

In contrast, Principles of Biology 102 was taught using a traditional approach (lecture and note taking). The data presented in this study indicates that the traditional

teaching methods used in the Biology course had a negative impact on paraeducators interest in teaching science. It is unfortunate that the paraeducators had a negative experience in their introductory Biology course. Reformed college science courses that use constructivist instructional strategies, like the ones used in the three mathematics course the UPDATE Scholars took, probably would have had a very different impact on these future educators' attitudes toward teaching science.

Research has shown that prospective teachers' attitudes and beliefs toward mathematics and science are key influences on how they teach (Ball, 1990a, 1990b; Moreiri, 1991; Peterson, Fennema, Carpenter & Loef, 1989; Oshima, 1966; Roth-McDuffie et al., 1996; Schoenfeld, 1985, 1989; Silver, 1985; Strawitz, 1976; and Watters & Ginns, 1997). If we want teachers that can use constructivist instructional strategies to teach math and science then we must change the way that math and science is taught at the college level as well as the K-12 level. Unfortunately, traditionally taught college level math and science courses continue to perpetuate the belief that knowledge should be passed down from teacher to student and that learning involves memorizing facts and information. Students are seen as empty vessels waiting to be filled, and teachers should do the filling. Lecturing informs students what they need to know, and students listen and memorize what they have been told.

Many undergraduate science courses continue to be fact-laden, non-inquiry oriented with cookbook laboratories. Because many pre-service teachers learned science by attending lectures and taking notes, it is not surprising that they view science as a body of knowledge which they are expected to transmit to children. When pre-service teachers finally begin teaching science in their own classrooms, they will remember how

they were taught. Many pre-service teachers have biased views about how science should be taught. In contrast, research supports the idea that pre-service teachers who participate in science courses taught using constructivist instructional methods (inquiry-based) will develop a positive attitude toward science, and this may translate into their interest in teaching science in the elementary classroom. The goal is to prepare teachers who can encourage children to ask their own questions and to allow children to find their own answers, not to tell children a bunch of facts and information about science so they can pass a test.

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Attitudinal Survey

You will be asked to fill out this survey at the beginning and end of this course. Your responses on this survey will be kept strictly confidential and will not affect you grade in this course in any way. Thank you for your participation!

The last 4 digits of your social security number _____

For each statement below, please indicate your agreement or disagreement by circling the number that best expresses what you think about the statement. **Your replies can range from Strongly Agree (SA = 1) to Strongly Disagree (SD = 5).**

	Strongly Agree		Not Sure		Strongly Disagree
1. Science does not interest me as much as other subjects.	1	2	3	4	5
2. I enjoy learning about science.	1	2	3	4	5
3. I am well prepared to teach science.	1	2	3	4	5
4. I am afraid to teach science because I can't do the experiments myself.	1	2	3	4	5
5. It is important that elementary level teachers fully understand the science areas students are investigating.	1	2	3	4	5
6. In science education, a few concepts explored deeply are more desirable as a goal than a broad overview.	1	2	3	4	5
7. I would be able to help someone learn science.	1	2	3	4	5
8. I am able to use technology to collect data and find new information.	1	2	3	4	5
9. I am interested in taking other college level science courses.	1	2	3	4	5

	Strongly Agree		Not Sure		Strongly Disagree
10. The idea of teaching science appeals to me.	1	2	3	4	5
11. I am able to devise a science investigation and carry it out.	1	2	3	4	5
12. I am able to make scientific observations and interpret them.	1	2	3	4	5
13. In performing experiments, the best learning is likely to take place if students are able to work alone.	1	2	3	4	5
14. I feel confident in my ability to help children learn to gather and interpret data.	1	2	3	4	5
15. I would prefer to learn science through laboratory experiments instead of from textbooks.	1	2	3	4	5
16. In general, boys do better in science than girls.	1	2	3	4	5
17. In general, boys are more interested in science than girls.	1	2	3	4	5
18. Science is truth. It is made up of a set of proven information.	1	2	3	4	5
19. I do not understand science concepts well enough to be effective in teaching elementary science.	1	2	3	4	5
20. Because of the amount of specific information to be taught in science, at least 50% of elementary science courses should be lecture.	1	2	3	4	5
21. Increasing scientific literacy means primarily increasing students' ability to read science texts and articles.	1	2	3	4	5

	Strongly Agree		Not Sure		Strongly Disagree
22. When a student has difficulty understanding a science concept, I am at a loss as to how to help the student understand it better.	1	2	3	4	5
23. It is important that children have science at every grade level.	1	2	3	4	5
24. It is important for the teacher to introduce all of the new vocabulary prior to an activity or experiment.	1	2	3	4	5
25. I feel confident in my ability to devise an investigation and carry out.	1	2	3	4	5
26. Incorrect ideas that students bring with them to the classroom are the results of poor teaching in an earlier grade and need to be corrected before the student can move on in science.	1	2	3	4	5
27. I feel confident in my ability to help children learn science.	1	2	3	4	5
28. Hands-on experiences should be part of every science class regardless of the content being taught.	1	2	3	4	5
29. You don't have to be knowledgeable in science to be good at teaching science.	1	2	3	4	5
30. The idea of teaching science scares me.	1	2	3	4	5
31. Reading and worksheets can be very effective ways to teach science.	1	2	3	4	5
32. If children are playing and talking during science experiments, not much learning is likely to take place.	1	2	3	4	5

	Strongly Agree		Not Sure		Strongly Disagree
33. It is important for students to understand how to use new technologies in the science classroom (i.e., computers, distance learning, CD-ROM, laser discs, computerized lab instruments.)	1	2	3	4	5
34. Knowing more science would affect my view of some things in everyday life.	1	2	3	4	5
35. Working in small groups is effective use of class time for encouraging learning.	1	2	3	4	5
36. Knowledge obtained in science courses does not relate to other subject areas.	1	2	3	4	5
37. Students should concentrate on learning facts already agreed upon in science, not discovering them on their own.	1	2	3	4	5
38. Lab activities and projects are best used to confirm information already studied.	1	2	3	4	5
39. Working in a science laboratory would be interesting.	1	2	3	4	5
40. Grading is a problem in cooperative groups.	1	2	3	4	5
41. Scientific work is useful only to scientist.	1	2	3	4	5
42. In general, I learn well from computerized instruction.	1	2	3	4	5
43. In general, I learn well from laboratory (hands-on) activities.	1	2	3	4	5
44. In general, I learn well from lectures.	1	2	3	4	5

	Strongly Agree		Not Sure		Strongly Disagree
45. In general, I learn well from videotapes.	1	2	3	4	5
46.In general, I learn well from readings.	1	2	3	4	5
47. In general, I learn well from cooperative groups.	1	2	3	4	5
48. In general, I learn well from independent projects.	1	2	3	4	5
49. I will typically be able to answer student's science questions.	1	2	3	4	5
50. Students in science should be discouraged from wild ideas and encouraged to think carefully and logically.	1	2	3	4	5
51. Even if I try hard, I will not teach science as well as I will most subjects.	1	2	3	4	5